



## Unlocking the Mysteries: Science on the Edge of Our Solar System

### Teacher Guide

#### Content Background

The National Aeronautics and Space Administration (NASA) Discovery Program uses the latest technology innovations to design exciting, lower-cost science investigations. All Discovery missions are unmanned and use robotic spacecraft to reach into the unknown, do what's never been done before, and drive new technology that may also improve life on Earth. The Discovery missions are grouped into three categories: 1) probe comets and asteroids and return to Earth with samples of materials and/or new information; 2) collect data and/or samples from the Sun, the Moon, and the planets; and 3) search for extra-solar planets that form solar systems around distant stars. All of these investigations will improve our understanding of the nature of our solar system, especially those objects closer to Earth.



NASA

The Discovery Program video, *Unlocking the Mysteries*, serves as the springboard for this classroom investigation and highlights the exciting work of the people who develop, test, and launch this series of robotic spacecraft. Ten mission segments depict each mission's purpose, timeline, and unique aspects in the form of mission footage and visually engaging simulations.

Students can learn more about the Discovery Program on its Web site at < <http://discovery.nasa.gov> >.



The site provides an overview of each mission, suggestions for educational activities, and additional resources. Each mission segment closes with the Internet address for that mission. Discovery mission Web sites provide access to extensive information about each mission, related educational activities, a description of the people involved, and detailed information about the science and technology of the mission.

#### What Students Do in this Activity

Students respond to a request from NASA to design a future robotic space science mission. They review the purpose and goals of the present round of missions that comprise the Discovery Program. Through in-depth research and experimentation, students become class experts about a single mission and present their findings to the class. Using the combined expertise, the class identifies the potential outcomes for the Discovery Program. Based upon their research, experimentation, and review of the Discovery Program, students develop detailed proposals for the next generation of robotic space missions.

#### Learning Goals

Students will:

- Identify and communicate to others the variety of space science exploration carried out by NASA.
- Use research skills to gain expertise about an individual NASA mission.
- Use oral and visual communication techniques to present findings to peers.
- Identify and communicate the needs of future scientific investigation.
- Use process-writing skills to respond to a NASA Discovery Program Announcement of Opportunity (AO) to submit a proposal.
- Identify and express the importance of science as related to the needs of society.

## National Standards Addressed

### Grades 5-8

#### [Science as Inquiry](#)

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of investigations
- Current scientific knowledge and understanding guides scientific investigations
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations
- Scientific investigations sometimes result in new ideas for study

#### [Earth and Space Science](#)

- Earth and the solar system

#### [Science and Technology](#)

Understandings about science and technology

- Scientific inquiry and technological design have similarities and differences
- Many different people and different cultures have made and continue to make contributions to science and technology
- Perfectly designed solutions do not exist
- Science and technology are reciprocal

#### [Science in Personal and Social Perspectives](#)

Science and technology in society

- Technology influences society through its products and processes
- Scientists and engineers work in many different settings

#### [History and Nature of Science](#)

- Science as a human endeavor
- Women and men of different backgrounds engage in activities of science
- Science requires different abilities

#### [Nature of Science](#)

- Scientists test their explanations of nature using observations, experiments and models
- It is part of scientific inquiry to evaluate the results of scientific investigations proposed by other scientists

[View a full text of the National Science Education Standards.](#)

## Preparation and Materials

Estimated Preparation Time: 15 minutes per session

Estimated Class Time:

- Approximately 5 hours to complete full unit.
- Approximately 3-1/2 hours to complete the unit without the hands-on activity.

## Materials

For the Teacher

- Video: *Unlocking the Mysteries*
- TV and VCR
- Chalkboard
- Poster paper
- Overhead transparencies of:
  - [AO letter](#)
  - Each student activity page (optional)



**Internet access required.**

For the Class

- Internet access
- Access to science laboratory and materials (optional)

#### For the Students

- Pencils
- [AO letter](#)
- Student Recording Sheets:
  - [Student Video Guide](#) (optional)
  - [Graphic Organizer](#) (optional)
  - [Mission Expert Research](#)
- Student Activity Sheet, "[Presenting the Research and Experiment Results](#)"
- [Internet Resources](#)

#### Unit at a Glance

| Session 1   | Session 2   | Session 3  | Session 4             | Session 5                                   | Session 6                                    | Session 7  |
|---|---|--|-----------------------|---|--|--|
| Introducing the Discovery Program: Reading the AO<br><br>Watching the Video | Assigning Mission Experts<br><br>Beginning Mission Research | Continue Research of Missions<br><br>Plan for Activities | Performing Activities | Presenting Results of Research & Activities | Reviewing and Responding to the Discovery AO | Sharing New Mission Concepts: Responding to the AO |

#### Advanced Preparation

- Read and review lesson plans and content background
- Review the video: *Unlocking the Mysteries*
- Arrange for Internet access
- Copy student pages (one per each individual)
- Review recommended activities (optional)
- Identify laboratory needs and access to materials and equipment
- Arrange classroom for discussion and viewing a video, Session 1
- Arrange classroom for research and experimentation, Sessions 2-4
- Arrange classroom for presentation and discussion, Sessions 5-7

#### Teacher Tip

Throughout this unit, use a graphic organizer or other method to help students organize what they know, want to know, and have learned (K-W-L).

#### Teacher Tip

Use an active reading strategy, such as reading in pairs or small groups, to increase student involvement. For a selection of strategies, see the publications listed in the resource section of this document.

#### Classroom Activities

##### Session 1: Setting the Scene

Explain to students that they will study space science and the latest missions of NASA's Discovery Program. Ask them to share what they already know about NASA and the U.S. and international efforts to explore space through missions and Earth-based research. List the student responses on the board.

##### Session 1: Introducing the Discovery Program: Reading and Reviewing the AO

Explain to students that you have received a request from NASA for your class to participate in the development of future robotic space missions. Tell them that the form of the request is in a



letter and that the professional term is called an “AO” or Announcement of Opportunity. Distribute a copy of the letter to each student. Ask for volunteers to read all or part of the letter aloud.

Following the reading, ask students to briefly explain or summarize the letter. Some questions to facilitate review of the letter include:

- What is it that NASA wants?
- What is a proposal?
- Why would NASA request suggestions from external individuals or groups?
- What individuals or organizations would likely respond to an AO?
- What are some things you need to do to meet the challenge from NASA?
- What do you think you need to learn about space exploration before you present your ideas to NASA?
- How will learning about present NASA Discovery missions help you prepare a proposal for a future mission?

#### Teacher Tip

Occasionally pause the video and help students review the various missions and their individual goals. If you want to provide students with time to take notes about each mission, have them record the name of the mission, what it is studying, and a description in their own words. Use the optional [Student Video Guide](#) to assist student note taking.

### Session 1: Viewing *Unlocking the Mysteries*

Explain to students that along with the AO, you also received a video that briefly explains about the missions that make up the Discovery Program. Also explain to students that they will form small groups and become the experts about one of the missions described in the video. As they watch the video, ask them to pay close attention to the goals of each mission as well as the goals of the program as a whole.

### Session 2: Assigning and Beginning Mission Research

If necessary, begin class by reviewing the Discovery Program goals < <http://discovery.nasa.gov> > and what is expected of students. Review the video and AO as needed. If students took notes while watching the video, have them look them over briefly. Assign teams and topics. Use a method that you are comfortable with such as assigning previously arranged teams, having students pick partners, or a random method.

Distribute and review the student activity sheet: [Mission Expert Research](#). Make certain that students understand that as the “mission experts” it will be their responsibility to identify:

- The purpose of the mission.
- The uniqueness of the mission including the scientific information gained and any special technology used to perform the work.
- How the individual mission contributes to the overall knowledge gained by the Discovery Program.
- The individuals or groups of scientists, engineers, and other personnel that contribute to the development and success of the mission.
- Any special or unexpected results of the mission.

#### Teacher Tip

Teams: Groups of two or three allow each student the opportunity to take responsibility for the work of becoming a mission expert. Based on your knowledge of the class, you may randomly assign students to groups or prepare the groups in advance.

**Topics: It is critical that each mission is researched.** You may want to let each team submit their top three mission choices, and then use a lottery system to assign one of these choices to each group.

#### Teacher Tip

Specific Internet addresses have been provided for the research and experiment portion of this unit. If students are not familiar with gathering information from the Internet, you may want to demonstrate how to access an Internet browser and open a specific Web site.

Explain any policies or expectations you have with respect to use of the Internet. Arrange the computer room seating so teams of students are near each other. Introduce students to the Discovery Program home page < <http://discovery.nasa.gov> > and bar at the top that links to the missions. Post the mission Web site addresses where students can see them. These addresses are found on the [Internet Resources](#) document.

Circulate around the room as teams research the mission for which they are responsible. Assist students in finding and recording the information requested on the Mission Expert Research page.

## NEXT STEP

The next two sessions include planning for and carrying out hands-on activities with your students. We encourage students to complete activities or build models to familiarize themselves with the missions and science associated with the Discovery Program. If you lack laboratory space or time, it is possible to respond to the NASA AO without doing the hands-on portion of this unit.

Many of the Discovery Program missions have Web sites that recommend experiments and activities for students to perform. The list of Internet addresses and recommended activities can be found on the [Internet Resources](#) document.

Depending on student ability and classroom resources, there are several ways to organize the class for the next phase of this unit. See suggestions listed below.

- Student teams perform one or more activities that relate to their selected mission.
- Identify one experiment or activity and arrange the classroom and supplies so that every student in the class performs the identical experiment.
- Use several of the experiments or activities to create a station-based laboratory class.

### Teacher Tip

Review the requirements for the recommended experiments and activities. Attempt one or more yourself to identify challenges, prior to working with students in the laboratory or classroom setting.

## Session 4: Performing Activities

Depending on your approach, student teams may perform a unique activity or one that other students have also performed.

As students work, check that they:

- Understand the purpose of the activity.
- Explain what they have learned as a result of performing the experiment or activity and how this will help them to respond to the NASA AO.

### Teacher Tip

The Council of State Science Supervisors (CSSS) has safety information and a publication (PDF), *Science and Safety, Making the Connection*, at: < <http://csss.enc.org/safety.htm> >

If students perform unique activities, explain that they will report their results at the same time they share all of the information regarding their mission. If students perform identical activities, consider reviewing the results of the experiment separate from the missions.

## Session 5: Presenting Results of Research and Activities

In this session, students serve in the role as mission experts and present their work. Allow them time to review their notes and plan for the presentation. Clearly post the important topics and questions that you expect students to address during their presentations.

The following list recommends some (but not all) of the possible issues students should cover in their presentation:

- The name of mission.
- The dates of mission.
- The purpose of the mission.
- The uniqueness of the mission, including the scientific information gained and any special technology used to perform the work.
- How the individual mission contributes to the overall knowledge gained by the Discovery Program.
- The individuals or groups of scientists, engineers, and other personnel that contributed to the development and success of the mission.
- Any special or unexpected results of the mission.

### Teacher Tip

Student presentations should provide the class with more details about each mission and a better understanding of the Discovery Program. If you choose not to have student oral presentations, then consider the following methods:

- poster sessions
- student-produced video (rather than live)
- discussion of the Discovery Program with teams leading a review of their mission

Younger students may prefer to write a song or poem about the mission.



- A brief description of the experiment students performed and results. (optional)

### Guidelines for Oral Presentations

Remind students that oral presentations provide an opportunity for them to practice important communication skills. Strong presentations and presenters:

- Are organized and have an obvious beginning, middle, and end.
- Engage the audience.
- Use visual aids.
- Include occasional and appropriate humor.
- Make eye contact with the audience.
- Appear relaxed.
- Speak clearly and explain technical terms.
- Dress appropriately for the setting.

#### Teacher Tip

Depending on available time and your expectations, the presentations may be formal or informal. For more formal events, enlist the support of other teachers, such as the language arts and special education teachers, to help students write and practice their presentations.

Remind the class that as an audience they should behave appropriately, listen carefully, and be prepared to ask questions of the presenters.

Once all the presentations have been completed, ask students to provide a written summary and to reflect on the overall outcomes of the Discovery Program. Use a graphic organizer, such as a web, to list each of the major areas of studies (comets and asteroids, near Earth objects, and planets around distant stars).

Reintroduce the AO letter and remind students that NASA encourages that next generation proposals expand upon and advance the work done by the original Discovery Program missions.

### Session 6: Reviewing and Responding to the Discovery AO

Explain to students that it is their turn to design a NASA mission. Ask them what they think NASA should concentrate on learning more about in the future and how the next generation of robotic missions can help scientists reach their goals. If necessary, refer students to their summary statements that they developed at the end of the presentations. Help the class brainstorm as many ideas as possible for areas of future scientific investigation of space. Remind students that during a brainstorming session all ideas are welcome. Record and save their ideas.

Some questions to assist students to brainstorm new mission concepts might include the following:

- What planets need to be explored or explored more completely?
- What new technology should be tested in space for exploration purposes?
- What questions did the present missions and Discovery Program leave unanswered?
- What interests you?
- What do you think would be useful information for the people of Earth to know about their solar system and beyond?
- What information can we gather from space that would improve life on Earth?

#### Teacher Tip

To support writing projects, develop or use a familiar graphic organizer. If students have saved their notes from the video, their research, their presentations, and their review of the Discovery Program web, use these to support the writing process. Remember to enlist the support of the language arts and special education teachers on your team should you need additional time with the writing aspect of this lesson.

Once students have brainstormed the various mission topics, have them review the original AO. Place a transparency of the original letter from NASA on the overhead and have students reread silently. Ask students to list what they must include in their response to the AO. A complete list will include at least the following:

#### NASA EXPECTS THE PROPOSAL TO:

- State the name of the new mission.
- Provide a detailed description of the purpose or goal of the new mission.
- Predict the length of time of the new mission.
- List the type of materials or data to be collected by the new mission.
- Explain the value of the new mission to science and society.
- Explain how the mission will share new knowledge with scientists and the public.
- Give an explanation of how the new mission will extend and expand the Discovery Program.
- Describe special or unique aspects of the mission and any associated new instrumentation that will further our science inquiry.
- List the personnel requirements for the new mission.
- The proposal should not exceed two pages.
- Students who are interested in the cost aspects of a Discovery mission can visit respective mission Web sites at < <http://discovery.nasa.gov/missions.html> > to determine the financial considerations of creating a budget for a NASA mission. (optional)

Once the class has developed a list of AO requirements, decide how students will respond to the NASA proposal. Some alternatives are listed below:

- Each student will write a different and individual response to the AO.
- Each mission team will write a response to the AO based upon their expertise gained through earlier research.
- The mission teams will be dispersed and new teams, consisting of experts from each mission, will write the response.
- The class will identify one mission concept and individuals will write responses.

Students will need time to do the following over the next day or two. Some of these activities might be done in class or as homework:

- Continue to brainstorm a mission goal or topic.
- Complete an outline of their mission that reflects the expectations of the AO.
- Draft a written response to the AO based upon the expectations listed in class.
- Edit and revise their draft response.
- Write or type a final response.

#### Session 7: Sharing New Mission Concepts: Responding to the AO

There are several methods for sharing the AO responses created by students or student teams. A few suggestions include:

- Students or teams briefly speak about the mission they have proposed in front of the whole class.
- Students or teams swap their completed AO packet with another team that reads and critiques the work using a rubric or checklist for recording comments.
- For classes in which each student creates a response, have students swap their work with one or more peers. For example, one peer that they choose and one chosen for them by the teacher.

#### Teacher Tip

During the peer review process, students should list strengths and weaknesses in the proposal based on the established criteria.



#### Extensions

This teacher guide has been written to provide flexibility for teachers with varying resources, knowledge, and students of various ages and abilities. Thus, depending upon the individual situation, there are opportunities throughout the unit to expand and emphasize each daily lesson. For example, classes with access to a laboratory and materials may choose to focus on the activities that relate to the unit. Teachers who want to stress communication skills, both written and oral, might emphasize the presentation and written response to the AO and

collaborate with the language arts teacher on the team. Additionally, individual students might wish to use this unit as the basis of an independent project for a science fair or for extra credit.

**Resources**

Harmin, M. (1994). *Inspiring active learning: A handbook for teachers*. Alexandria, VA. Association for Supervision and Curriculum Development.

Marzano, R., Pickering, D., Pollock, J. (2001). Summarizing and note taking. In *Classroom instruction that works* (pp. 29-48). Alexandria, VA: Association for Supervision and Curriculum Development.

Saphier, J., & Haley, M. A. (1993). *Summarizers*. Acton, M.A. Research for Better Teaching, Inc.